Prepared in cooperation with the
SUFFOLK COUNTY WATER AUTHORITY
and
SUFFOLK COUNTY DEPARTMENT OF ENVIRONMENTAL CONTROL

GROUND-WATER SYSTEM

RECHARGE AND DISCHARGE OF FRESH GROUND WATER

Precipitation is the sole source of fresh-water recharge in the county. Average annual precipitation is about 45 inches; it generally ranges from 40 inches at the eastern end of the county to 50 inches in the middle and is nearly evenly distributed over the year (Miller and Frederick, 1969, plate 1). About half the precipitation seeps into the ground and percolates downward to the water table to become ground water; nearly half the precipitation is returned to the atmosphere by evaporation and plant transpiration; and a small amount of the precipitation, about 5 percent, enters streams by direct runoff (Cohen and others, 1968, p. 36–40, and Cohen and others, 1970, p. 11 and 14).

Ground water moves to discharge seaward mainly by subsurface outflow to salty ground water that is hydraulically connected with the sea and by seepage into streams that discharge into tidewater.

More than 50 streams discharge fresh water into the bordering bays, Long Island Sound, and the ocean. Most of the surface divide for the streams that drain the county lies in the northern half and extends from Melville, on the west, eastward through the Centereach area to the vicinity of the Brookhaven National Laboratory. From the area of the Brookhaven National Laboratory, the divide bifurcates into branches that approximately traverse the central lengths of the county's north and south forks. Streams flow to tidewater north and south of the divides, except for the Peconic River, which flows eastward to tidewater from the branching of the divides.

The total annual streamflow discharging into tidewater from about 1945 to 1971 averaged 390 cfs (cubic feet per second), or 253 mgd, distributed as follows (D.E. Vaupel, written commun., January 1969, and A.G. Spinello, oral commun., August 1971): most of the discharge, 280 cfs, from the southern part of the county into Great South Bay and, to a lesser extent, into the ocean; 60 cfs into Peconic Bay and other bays, between the north and south forks; and 50 cfs from the northern part of the county into Long Island Sound. Ground-water seepage constitutes about 95 percent of stream outflow.

MAN-MADE CONDITIONS

The effects of man's development on the ground water of Suffolk County has primarily been the diversion of part of it by wells and a return of the used, and generally chemically altered, ground water to the soil and ground-water reservoir. Used ground water is currently returned to the ground-water reservoir principally through cesspools. Some waste water from industrial processes returns to the ground through seepage pits; and ground water pumped for air conditioning and industrial cooling is returned, with higher temperatures, through recharge wells to the ground-water reservoir. Ground water pumped for crop irrigation and lawn sprinkling mostly represents a net loss from the system by evapotranspiration. Artificial filling of marshy shore areas has probably reduced evapotranspiration.

In 1970, gross ground-water pumpage in Suffolk County was 155 mgd (New York State Department of Environmental Conservation, written commun., June 1, 1971). An unknown amount of the pumpage was consumed by evapotranspiration, and virtually all the remainder (probably more than 75 percent) was returned to the ground through local waste-disposal facilities.

MOVEMENT OF GROUND WATER

Ground water moves from three major drainage subareas toward discharge at or near the shore. These subareas are (1) the main land area of the county from the Nassau County boundary to a point near the Brookhaven National Laboratory, (2) the north fork, from the Brookhaven National Laboratory to Orient Point, and (3) the south fork, from the Brookhaven National Laboratory to Montauk Point. The ground-water divides of these subareas form a "Y"-shaped pattern that approximately coincides with the major surface-water drainage divides. The arms of the Y radiate from the general area of the Brookhaven National Laboratory through the centers of the north and the south forks. Ground water moves northward toward Long Island Sound and southward toward Great South Bay and the ocean; lesser amounts in the Brookhaven National Laboratory and Riverhead areas percolate eastward toward Peconic Bay. Ground-water drainage from the north-fork area moves northward to Long Island Sound and southward into Peconic and Gardiners Bays and Block Island Sound; in the south fork area, ground water moves northward to Peconic and Gardiners Bays and southward into Moriches and Shinnecock Bays and the ocean.

Movement of water in the aquifers of Suffolk County is more rapid horizontally than vertically. This partly reflects the low vertical hydraulic conductivity of the near-horizontal interbedded clay and silt lenses and beds. The estimated average rates of horizontal movement in the upper glacial, the Magothy, and the Lloyd aquifers are 0.5, 0.2, and 0.1 foot per day, respectively, in areas remote from pumping wells, and hundreds of feet per day near the screens of pumping wells (Soren, 1971a, p. 16). Vertical rates of movement are described in the following section.

HYDRAULIC INTERCONNECTION OF AQUIFERS

The aquifers of Long Island are hydraulically interconnected. Layers of clay and silt within an aquifer, or clayey and silty units between aquifers, confine the ground water; but these units do not completely prevent the vertical movement of water through them.

On the average, the vertical hydraulic conductivity of and rates of vertical flow through the upper glacial aquifer are greater than those of all other hydrogeologic units in Suffolk County. The vertical movement of water through the Magothy aquifer is impeded by intercalated lenses and beds of clay and silt; but, locally, vertical movement through the aquifer is facilitated by the lateral discontinuity of clay and silt beds. Vertical movement of water through clay and silt beds of the Magothy aquifer is very slow. The Raritan clay effectively confines water in the underlying Lloyd aquifer because the Raritan clay is thick, is areally persistent, and is of very low hydraulic conductivity. Movement through the bedrock is negligible.

The contact between the upper glacial and the Magothy aquifers is not a smooth plane. Glacial deposits fill buried valleys that were cut in the Magothy aquifer, and these deposits are in lateral contact with truncated beds in the Magothy aquifer. In the buried valleys, water enters the Magothy aquifer at depths of hundreds of feet directly from the upper glacial aquifer. Near Huntington, a buried valley cuts completely through the Magothy aquifer and extends into the Raritan clay; in the Ronkonkoma basin, the Magothy aquifer seems to be nearly completely cut through; and along the north shore, where locally all the pre-Pleistocene deposits were completely eroded, the upper glacial aquifer is in contact with the full thickness of the Magothy aquifer. (See map showing altitude of top of Magothy aquifer and hydrogeologic sections, sheet 1.)

Where the upper glacial aquifer lies directly on sandy beds of the Magothy aquifer, good vertical hydraulic continuity exists between the two aquifers. Head losses between the water table in the upper glacial aquifer and the base of the Magothy aquifer in the area of the main ground-water divide in western Suffolk County (a vertical distance of as much as 900 feet) in 1968 generally were less than 2 feet (Soren, 1971a, p. 17–19). Furthermore, in areas of Long Island where ground-water withdrawals from both the upper glacial and the Magothy aquifers are large, the cones of depression in their water-level surfaces caused by pumping are similar in areal extent and configuration (Soren, 1971b, p. 15; and Kimmel, 1971, p. B227–B228). These observations confirm the high degree of interconnection between the two aquifers in many parts of the county.

In the south shore area, the Gardiners Clay and the Monmouth greensand effectively confine water in the Magothy aquifer; and the high degree of confinement helps to prevent the downward movement of salty ground water into the Magothy aquifer. Wells that tap the Magothy aquifer on the barrier bars yield fresh water and commonly flow at land surface.

Recharge to the Lloyd aquifer results from downward movement of water from the Magothy aquifer and from the upper glacial aquifer through the Raritan clay. The main recharge area of the Lloyd aquifer seems to be in the Ronkonkoma area. Head losses across a thickness of 150 to 180 feet of Raritan clay in the county generally ranged from 6 to 42 feet in 1968 (Soren, 1971a, p. 17).

GROUND-WATER LEVELS

THE WATER TABLE

The water table on Long Island was first mapped in 1903 (Veatch and others, 1906, pl. 12). At that time its highest point in Suffolk County was 100 feet above sea level, near Melville on the main ground-water divide near the Nassau County border, and was 70 feet above sea level at another high point on the divide in the Lake Ronkonkoma-Selden area. Subsequent maps show that water-table altitudes have continued to be highest in these two areas but had declined to 80 and 65 feet respectively in both 1943 and 1951 (Jacob, 1945, pl. 1; and Lusczynski and Johnson, 1951, pls. 1–2); rebounded to 90 and 70 feet by 1958 (Lubke, 1964, pl. 5); and had reached new lows of 70 and 65 feet by 1968 (Soren, 1971a, p. 20). The latest significant decline probably resulted mainly from a regional drought from 1962 to 1966 (Cohen, Franke, and McClymonds, 1969, p. 1).

The water-table map shows the altitude of the water table in early 1971. At that time, in the Melville area it was about 5 feet higher than in 1968, and in the Lake Ronkonkoma-Selden area it was about 5 feet lower. The water table still has not recovered from the apparent effects of the 1962–66 drought in areas of significant pumping, partly because of increased net withdrawals since 1966.

PERCHED GROUND WATER

Locally, layers of clay above the water table retard the downward movement of water and create ground-water bodies that are perched above the water table. Many lakes in the inter-terminal-moraine area lie above the water table. These lakes are in hydraulic continuity with surrounding small perched ground-water bodies.

According to Lubke (1964, p. 28), bodies of perched ground water are found in the deposits of the Harbor Hill Terminal Moraine in the vicinity of Huntington and in localities in Northport, the northern Smithtown area, the northern Deer Park area, and the Lloyd Harbor area. Perched ground-water levels as much as 250 feet above the water table are reported in the Huntington area by Veatch and others (1906, pl. 12). In the northern half of Suffolk County, in areas where shallow observation wells are few, data from wells tapping unrecognized bodies of perched ground water can lead to erroneous mapping of the regional water table. Perched ground water is not known to occur in the county south of the Ronkonkoma Terminal Moraine.

Most perched ground-water bodies on Long Island are too small to support large-scale sustained pumpage for public supply, and many of the perched bodies are probably too small to support even small-scale pumpage for more than a few houses.

POTENTIOMETRIC SURFACES

MAGOTHY AQUIFER

Because of the tendency for water to be increasingly confined with increasing depth in the Magothy aquifer and because of the irregular geometry and recharge pattern of this aquifer, its most readily mappable water-level surface is the potentiometric surface in the lower to basal part. (A potentiometric surface of a confined aquifer is the imaginary surface to which water rises in wells that tap the aquifer.) The potentiometric surface of the lower Magothy aquifer in Suffolk County in early 1971 is depicted.

Hydraulic gradients deduced from comparison of the water table (water-table map) and the potentiometric surface of the lower Magothy aquifer (potentiometric-surface map) indicate that the Magothy aquifer is almost entirely recharged by downward leakage from the upper glacial aquifer along the area of the main ground-water divide. In the shoreline areas of the county, hydraulic heads in the Magothy aquifer are higher than those in the upper glacial aquifer; and in these areas, some water in the Magothy discharges by upward leakage into the upper glacial aquifer.

LLOYD AQUIFER

Few wells are screened in the Lloyd aquifer in Suffolk County; consequently, little information on the potentiometric surface of this unit is available. In early 1971, only four observation wells screened in the Lloyd aquifer provided reliable head data for the central to western parts of the county. The wells are located at the Brookhaven National Laboratory; in the Lake Ronkonkoma Village area; at the west end of Fire Island; and in nearby Nassau County, adjacent to the Melville area. The highest potentiometric head measured in 1971, 36 feet above sea level, was in the Lake Ronkonkoma area.

IMPLICATIONS OF WATER-LEVEL CHANGES

In undeveloped areas of Suffolk County, where hydrologic conditions are natural or nearly so, water levels in the aquifers fluctuate several feet during a year. In such areas, ground-water levels are generally highest in early spring and lowest in late autumn. These conditions reflect greater recharge, resulting from low evapotranspiration from late autumns to early spring, and lesser recharge, resulting from high evapotranspiration from early spring to late autumn. Under natural conditions, long-term average annual ground-water discharge was balanced by recharge, and the hydrologic system was in equilibrium.

When water is withdrawn from an aquifer, hydraulic heads in wells tapping the aquifer decline to form a conical depression whose apex commonly is centered at or near the pumping wells. The cone will continue to expand unless or until sufficient additional recharge is induced or sufficient natural discharge is salvaged. On Long Island, a decline in ground-water levels represents mainly a loss of ground water from storage and a reduction of ground-water discharge to streams. Subsurface outflow of ground water to the sea also may be reduced where a part of the outflow is salvaged by pumping; but where fresh ground water is contiguous with salty ground water, such a decrease in subsurface fresh-water outflow allows salty ground water to move landward in the aquifers.

QUALITY OF THE GROUND WATER

The concentrations of chemical constituents in the ground water in most of Suffolk County are generally below the recommended maximum limits of the U.S. Public Health Service (1962, p. 7). However, some local water-quality problems exist, both natural and man-made.

ACIDITY

The pH of ground water ranges from 5.5 to 7.2 but is generally less than 7.0. The water commonly is sufficiently acidic to be corrosive. The Public Health Service has set no standards on acidity of drinking water other than that it should not be excessively corrosive to the supply system (1962, p. 7). Accordingly, water from many public-supply systems is treated with alkaline compounds to reduce acidity before distribution.

DISSOLVED IRON

According to the U.S. Public Health Service (1962, p. 7), dissolved iron concentrations in drinking and culinary water should not exceed 0.3 mg/l (milligram per liter). Excessive iron impairs the taste of water and of food and beverages prepared with the water; it also stains laundry and stains and clogs plumbing fixtures. High iron concentrations, locally more than 1 mg/l, are common in water from the Magothy and the Lloyd aquifers. As a result, many public-water suppliers remove excessive iron.

CHLORIDE

Along the seaward margins of the county, the fresh ground water is underlain and bordered by salty ground water that is hydraulically connected to the ocean, the bays, or Long Island Sound. Zones of mixed water, called zones of diffusion, separate the fresh and the salty ground water. The thickness of these zones probably ranges from a few feet in the upper glacial aquifer to as much as 500 feet in the Magothy aquifer (Lusczynski and Swarzenski, 1966, p. 23). The chloride content of the ground water in the zone of diffusion ranges from less than 10 mg/l to that of sea water—about 18,000 mg/l.

Contamination of the fresh ground water with salty ground water associated with the upward and landward movement of the zones of diffusion has not resulted in the abandonment of many wells in Suffolk County. However, the long-term potential threat of increased contamination of this type is of concern to numerous agencies and individuals in the county. A detailed discussion of this potential problem is beyond the scope of this report; however, considerable insight to the problem can be obtained from reports by Crandell (1962, p. 17–19, and 1963, p. G28–G31), Perlmutter and DeLuca (1963, p. B31–B34), Lusczynski and Swarzenski (1966, p. F66–F69), Holzmacher, McLendon, and Murrell (1970, p. 247–271), Collins and Gelhar (1970, p. 144–150), and Soren (1971b, p. A31–A34).

DETERGENT CONSTITUENTS (MBAS)

More than 95 percent of the ground water used for domestic supply in Suffolk County is returned to the ground through cesspools, septic tanks, and similar structures. As a result, the ground water and the ground-water-fed streams locally contain measurable amounts of certain substances of sewage origin, including foaming agents derived from synthetic detergents, commonly referred to as MBAS or methylene blue active substances. MBAS has been noted mainly in water from the upper glacial aquifer (Perlmutter and Guerrera, 1970, p. B14) and in the streams (Cohen, Vaupel, and McClymonds, 1971). Apparently, little or no MBAS had been found in water in the Magothy and the Lloyd aquifers. Where MBAS has been found in the water, the content is commonly less than 0.5 mg/l, the maximum limit in public-supply water recommended by the U.S. Public Health Service (1962, p. 24). However, locally, as much as 5 mg/l has been found in the ground water; and in some areas the MBAS content of the water seems to be increasing. As a result, the Suffolk County Legislature recently (1971) passed a law banning the sale of certain detergents in the county. In addition, plans have been developed for the construction of widespread sanitary-sewer systems that will discharge treated waste water into the sea.

NITRATE

The amount of nitrate in the ground water of Suffolk County is of concern of water managers and health officials. According to the U.S. Public Health Service (1962, p. 7) more than 45 mg/l nitrate (10 mg/l NO_3-N) in water supplies may be harmful, especially to infants. Perlmutter and Koch (1972, p. B230) estimated that the average natural background level of nitrate in ground water of Nassau and Suffolk Counties was less than 1 mg/l (less than 0.2 mg/l NO_3-N).

Numerous wells in Kings County (G.E. Kimmel, written commun., August 1971), Queens County (Soren, 1971b, p. A30–A31), Nassau County (Perlmutter and Koch, 1972), and Suffolk County (Harr, 1971) yield water containing more than 0.2 mg/l NO_3-N. Moreover, at least 50 wells on Long Island yield water containing more than 10 mg/l NO_3-N.

The amount of water having more than 0.2 mg/l NO_3-N, its rate of increase, and the depth at which it is found seem to increase westward on Long Island as a whole, as well as in Suffolk County. These relations probably largely reflect the westward increase in population density, the westward increase in the age of the communities, and the associated degree of contamination of the ground water related to man's activities.

In Suffolk County, the two major sources of nitrate nitrogen in the ground water are (1) disposal of waste water into the ground and (2) agricultural activities, especially those involving the use of fertilizers. A planned countywide sanitary-sewer system is intended to reduce sewage as a source of nitrate nitrogen in the ground water of Suffolk County.

GROUND-WATER PUMPAGE

Pumpage from Suffolk County's aquifers increased from about 40 mgd in 1950 to about 155 mgd in 1970, to supply a population that has been increasing rapidly since the end of World War II. The greatest increases in population and ground-water pumpage have been in the western part of the county. Before about 1960, wells tapping the upper glacial aquifer supplied nearly all the water used in Suffolk County. Since then, pumpage from the Magothy aquifer has increased, and in 1970, the wells tapping the Magothy aquifer supplied about one-third the water used. (See map showing areal distribution of major pumpage by aquifer 1970.)

CHANGES OF GROUND WATER IN STORAGE

An area of about 140 square miles in west-central Suffolk County is underlain by about 4.5 trillion gallons of fresh water (Soren, 1971a, p. 20). By extrapolation, the total fresh ground water beneath all the county is probably 4 to 5 times this volume.

Withdrawals of ground water have caused the water table in some parts of the county to decline as much as 25 feet from earliest known levels in 1903 (map showing net change in the position of the water table) and have probably caused a small regional but generally undetected landward advance of salty ground water. The decline of the water table reflects a loss of 60 to 80 billion gallons of fresh water from the ground-water reservoir between 1903 and 1971. However, this loss of ground water from storage is less than 1 percent of the total ground water in storage in Suffolk County.

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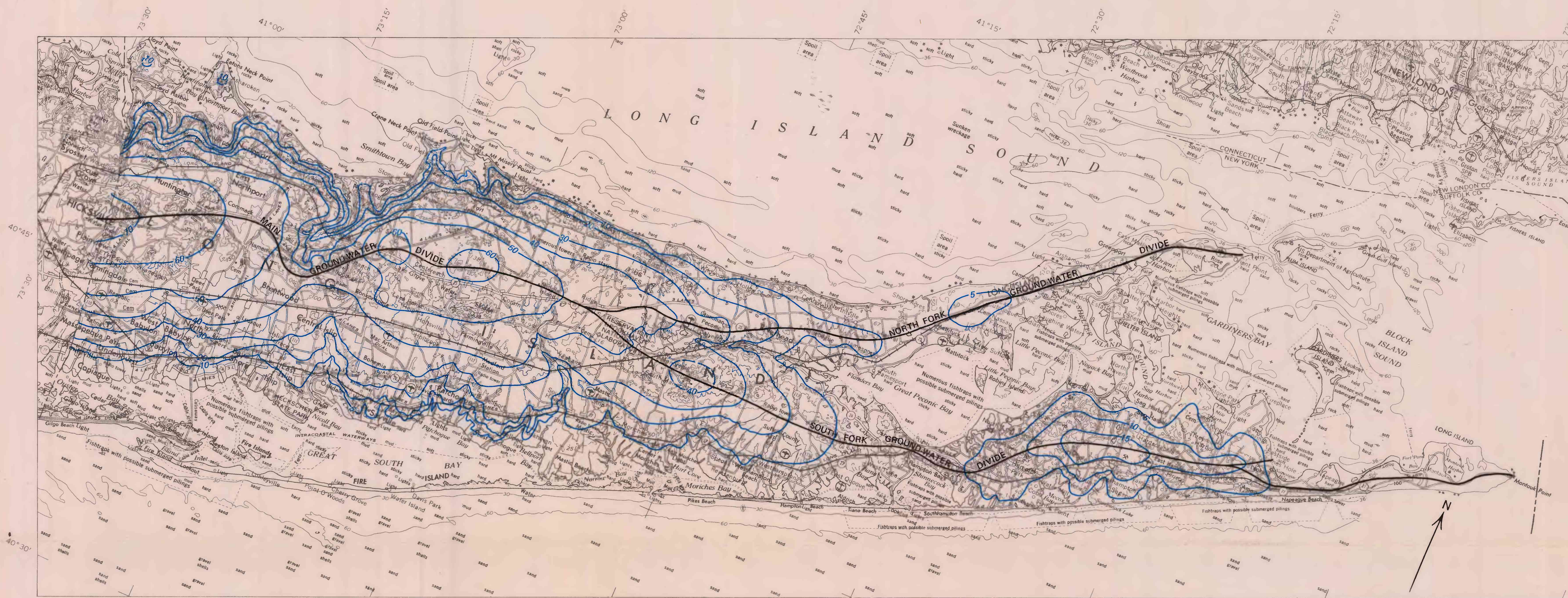
[1] Publishing agency is presently known as "New York State Department of Environmental Conservation."

EXPLANATION

APPROXIMATE WATER-TABLE CONTOUR – Shows altitude of water table. Dashed where inferred. Contour intervals 5 and 10 feet. Datum is mean sea level



Hydrology by H.M. Jensen and Julian Soren, 1971 (Adapted in part from Kimmel, 1971)

MAP SHOWING ALTITUDE OF WATER TABLE, SPRING 1971

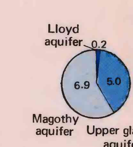
EXPLANATION

APPROXIMATE POTENTIOMETRIC CONTOUR – Shows altitude of potentiometric surface. Dashed where inferred. Contour interval 10 feet. Datum is mean sea level

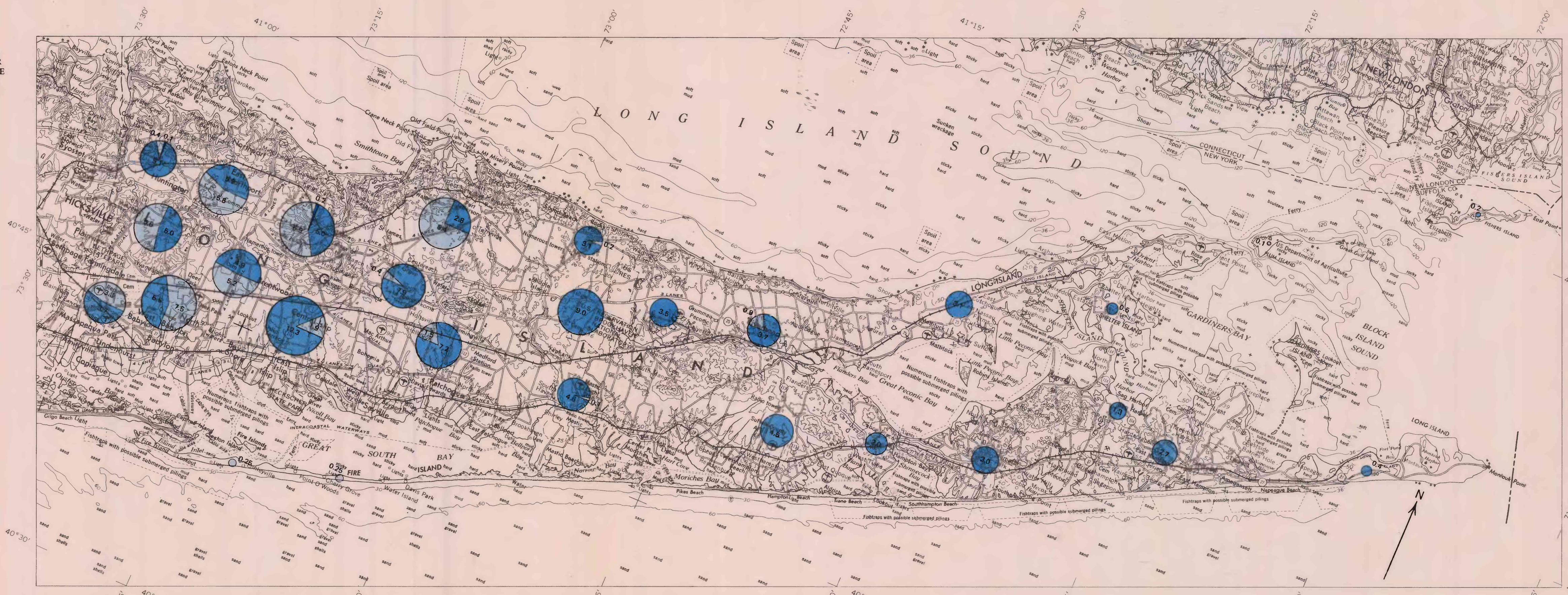
Hydrology by H.M. Jensen and Julian Soren, 1971

MAP SHOWING POTENTIOMETRIC SURFACE OF WATER IN THE LOWER PART OF THE MAGOTHY AQUIFER, SPRING 1971

EXPLANATION



APPROXIMATE AREAL CENTER OF MAJOR GROUND-WATER PUMPING AND SOURCE AQUIFERS – Diameter of circle is proportional to pumpage; number is average daily pumpage, in million gallons per day

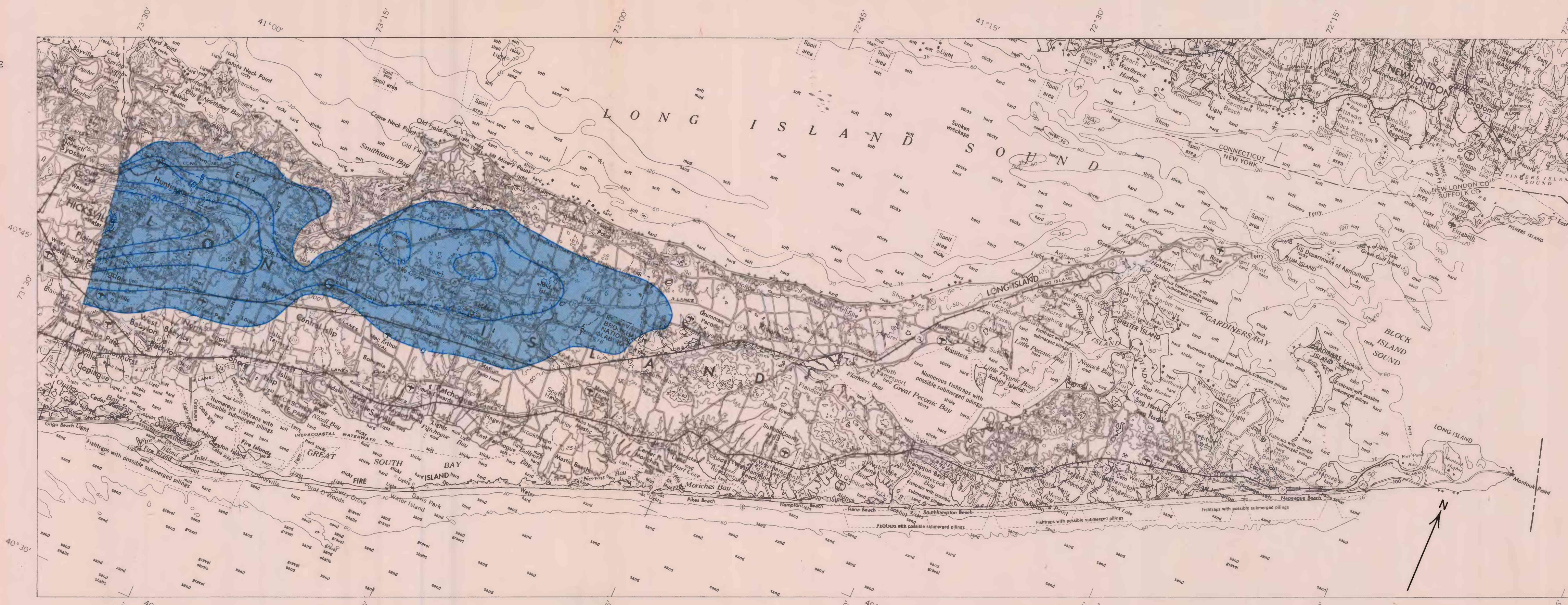


MAP SHOWING AREAL DISTRIBUTION OF MAJOR PUMPAGE BY AQUIFER, 1970

EXPLANATION

AREA OF WATER-TABLE DECLINE

LINE OF EQUAL WATER-LEVEL DECLINE – Interval 5 feet



Base from U.S. Geological Survey, Hartford, 1962; New York, 1957; and Providence, 1967

MAP SHOWING APPROXIMATE NET CHANGE IN THE POSITION OF THE WATER TABLE FROM 1903 TO 1971
(Based in part on data from Veatch and others, 1906, pl. 12)

SCALE 1:250 000

CONTOUR INTERVALS 25, 50, AND 100 FEET
DATUM IS MEAN SEA LEVEL

HYDROGEOLOGY OF SUFFOLK, COUNTY, LONG ISLAND, NEW YORK

By
H. M. Jensen and Julian Soren

1974